A CLAIM OR CLAIMS

I claim:

1. A finishing apparatus comprising:

a workpiece carrier for holding a workpiece surface;

a finishing surface positioned proximate the workpiece surface;

a mechanism for applying an operative finishing motion to an operative finishing interface comprising the workpiece surface and the finishing element finishing surface; and

a control subsystem having at least one friction sensor for in situ control of a finishing control parameter in the operative finishing interface and the control subsystem having access to memory look-up tables and to cost of manufacture information.

2. The finishing apparatus according to claim 1 wherein the at least one friction sensor comprises at least two friction sensors.

3. The finishing apparatus according to claim 1 wherein the control subsystem has access to finishing uniformity parameters.

4. The finishing apparatus according to claim 1 wherein the control subsystem has access to finishing uniformity parameters selected from the group consisting of Total Thickness Variation, Focal plane deviation, Within-Wafer Non-Uniformity, and surface quality.

5. The finishing apparatus according to claim 1 wherein the control subsystem has multiple workpiece sensors and access to differential information from multiple workpiece sensors.

6. The finishing apparatus according to claim 1 wherein the control subsystem has multiple friction sensors and access to differential information from multiple friction sensors.

7. The finishing apparatus according to claim 1 wherein the finishing surface comprises a finishing surface of a finishing element and wherein the finishing element has a lubricant in at least a portion of the finishing element proximate to the finishing surface.

8. The finishing apparatus according to claim 1 wherein the finishing surface comprises a finishing surface of a finishing element and wherein the finishing element comprises foamed organic synthetic polymer.

9. The finishing apparatus according to claim 1 wherein the finishing surface comprises a finishing surface of a finishing element and wherein the finishing element comprises the finishing element comprising a compressible porous material.

10. A finishing apparatus comprising:
a workpiece carrier for holding a workpiece surface;
a finishing surface positioned proximate the workpiece surface;
a mechanism for applying an operative finishing motion to an operative finishing interface comprising the workpiece surface and finishing element finishing surface; and
a control subsystem for in situ control for finishing in the operative finishing interface and the control subsystem having access to algorithms, memory look-up tables, and cost of manufacture information.

11. The finishing apparatus according to claim 10 wherein:
the control subsystem has sensors selected from the group consisting of multiple friction sensors and multiple friction sensors; and
the control subsystem has access to differential information from sensors selected from the group consisting of the multiple friction sensors and the multiple friction sensors.

12. The finishing apparatus according to claim 10 wherein the control subsystem has sensors selected from the group consisting of multiple friction sensors and multiple friction sensors.

13. The finishing apparatus according to claim 10 wherein the control subsystem has access to friction sensor information combined with workpiece sensor information.

14. The finishing apparatus according to claim 10 wherein the control subsystem has access to feedback information selected from the group consisting of finishing rate information and product quality information.

15. The finishing apparatus according to claim 14 wherein the algorithms comprise at least in part neural networks.

16. The finishing apparatus according to claim 15 wherein the finishing surface comprises a finishing surface of a finishing element and wherein the finishing element comprises comprising an organic synthetic polymer of a compressible porous material.

17. The finishing apparatus according to claim 10 wherein the subsystem controller further includes access to a historical performance.

18. The finishing apparatus according to claim 10 wherein:

the finishing surface comprises a finishing surface of a finishing element and wherein the finishing element comprises comprising an organic synthetic polymer of a compressible porous material; and

the control subsystem has access to the algorithms, the memory look-up tables, the cost of manufacture information, and historical performance including a quantity of historical information of the workpiece and a quantity of historical information of prior workpieces

19. A finishing apparatus comprising:

a workpiece carrier for holding a workpiece surface;

a finishing surface positioned proximate the workpiece surface;

a mechanism for applying an operative finishing motion to an interface comprising the workpiece surface and finishing surface; and

a controller subsystem having at least one operative sensor for in situ control of a finishing control parameter and the controller subsystem having access to algorithms, memory look-up tables, and a cost of manufacture information tracked and stored by workpiece.

20. The finishing apparatus according to claim 19 wherein the cost of manufacture information tracked and stored by workpiece is included at least in part in the memory look-up tables

21. The finishing apparatus according to claim 19 wherein the algorithms include at least in part neural networks.

22. The finishing apparatus according to claim 19 wherein:

the controller subsystem has access to the algorithms, the memory look-up tables, and the cost of manufacture information tracked and stored by workpiece, and a historical performance; and wherein

the cost of manufacture information tracked and stored by workpiece and the historical performance are included at least in part in memory look-up tables.

23. A method of finishing of a semiconductor wafer having a semiconductor wafer surface comprising the steps of:

providing a finishing surface;

positioning the semiconductor wafer surface proximate to the finishing surface;

providing at least one operative friction sensor for sensing in situ finishing information;

applying an operative finishing motion between the semiconductor wafer surface and the finishing surface forming an operative finishing interface having a friction;

sensing an in situ finishing information with the operative friction sensor and sending the in situ finishing information to a processor having access to a cost of manufacture information;

evaluating at least one process control parameter for improved adjustment using at least in part the cost of manufacture information and the in situ finishing information; and

controlling the at least one process control parameter to change the finishing of the semiconductor wafer.

24. The method of finishing according to claim 23 wherein the semiconductor wafer has a plurality of low-k dielectric layers, each having a value of less than 3.5.

25. The method of finishing according to claim 23 wherein the semiconductor wafer surface has a plurality of metal layers.

26. The method of finishing according to claim 23 wherein semiconductor wafer is finished on at least a plurality of layers and the control of the at least one process control parameter to change the finishing is different for at least a plurality of the different layers.

27. A processor-readable, program storage device encoded with instructions that, when executed by a processor, performs the method of claim 26.

28. A process controller at least in part controlled by a processor having access to a processor readable medium with processor readable instructions for performing the method of claim 26.

29. The method of finishing according to claim 23 wherein the finishing surface comprises, at least in part, an abrasive polymeric material.

30. The method of finishing according to claim 23 wherein the operative finishing interface comprises, at least in part, an abrasive polymeric material.

31. A method of finishing a semiconductor wafer surface having a finishing cycle time comprising the steps of:

providing a finishing surface;

positioning the semiconductor wafer surface proximate to the finishing surface;

providing an organic lubricant to an interface formed between the semiconductor wafer surface and the finishing surface;

providing at least three operative sensors for sensing in situ finishing information;

applying an operative finishing motion between the semiconductor wafer surface and the finishing surface forming an operative finishing interface with at least one friction;

sensing the in situ finishing information with the at least at least three operative sensors and sending the in situ finishing information to a processor having access to cost of manufacture information;

evaluating at least one process control parameter for improved adjustment using at least in part the cost of manufacture information and the in situ finishing information; and

controlling and adjusting the at least one process control parameter to change the finishing of the semiconductor wafer during the finishing cycle time.

32. A method of finishing according to claim 31 wherein controlling and adjusting comprises changing the at least one process control parameter to change the tangential force of friction in the operative finishing interface.

33. A processor-readable, program storage device encoded with instructions that, when executed by a processor, performs the method of claim 31.

34. A process controller at least in part controlled by a processor having access to a processor readable medium with processor readable instructions for performing the method of claim 31.

35. A method of finishing a semiconductor wafer having a semiconductor wafer surface and having a finishing cycle time comprising the steps of:

providing an finishing surface;

positioning the semiconductor wafer surface proximate to the finishing surface;

providing a finishing composition to an interface formed between the finishing surface and the semiconductor wafer surface;

providing at least one operative sensor for sensing in situ finishing information about the finishing;

applying an operative finishing motion between the semiconductor wafer surface and the finishing surface forming an operative finishing interface;

sensing the in situ finishing information with the at least one operative sensor and sending the information about the finishing to a processor having access to a cost of manufacture information;

evaluating finishing control parameters for improved adjustment using at least in part the cost of manufacture information and the in situ finishing information; and

controlling at least one process control parameter during the finishing cycle time to change the finishing of the semiconductor wafer.

36. The method of finishing according to claim 35 wherein the semiconductor wafer surface has at least one uniform region and wherein controlling at least one process control parameter comprises controlling the at least one process control parameter to control a coefficient of

friction in at least the one uniform region of the semiconductor wafer surface during the finishing cycle time.

37. The method of finishing according to claim 35 wherein the semiconductor wafer surface has at least one uniform region and wherein controlling the at least one process control parameter comprises controlling the at least one process control parameter to control a tangential force of friction in at least the one uniform region of the semiconductor wafer surface during the finishing cycle time.

38. A method of finishing according to claim 35 wherein controlling at least one process control parameter comprises changing the at least one process control parameter to change the tangential force of friction in at least two regions of the operative finishing interface.

39. A method for finishing a semiconductor wafer having tracked information, the method comprising:

a step (A) providing a semiconductor wafer;

a step (B) providing a finishing surface;

a step (C) providing an organic lubricant;

a step (D) providing at least one control subsystem having at least three operative process sensors, at least one processor, and a controller and wherein the at least one processor for processing:

(i) the tracked information,

(ii) historical performance including a quantity of historical performance of prior semiconductor wafers, and

(iii) a cost of manufacture information;

a step (E) applying an operative finishing motion to an interface between the semiconductor wafer and the finishing surface and wherein the interface includes the organic lubricant;

a step (F) sensing an in situ finishing information during finishing with the at least three operative process sensors during a finishing cycle time;

a step (G) evaluating a multiplicity finishing information and wherein at least a plurality of the multiplicity of the finishing information has an effect on a cost of manufacture of the semiconductor wafer;

a step (H) determining a change for at least one process control parameter using:

(i) the tracked information,

(ii) the historical performance including the quantity of historical performance of prior semiconductor wafers,

(iii) the cost of manufacture information,

(iv) the in situ finishing information, and

(v) the step (G) of evaluating the multiplicity of finishing information; and

a step (I) changing the at least two of control parameters to change the finishing on at least one region of semiconductor wafer surface during the finishing cycle time.

40. A method according to claim 39 wherein the step (G) and (H) are performed at least in part during the same time.

41. A method according to claim 39 wherein the step (G) and (H) are performed at least in part at different times.

42. A processor-readable, program storage device encoded with instructions that, when executed by a processor, performs the method of claim 39.

43. A control subsystem having access to a manufactured article having a processor readable medium with processor readable instructions for performing the methods of claim 39.

44. At least three control subsystems according to claim 43 wherein the at least three control subsystems are in operative communication with each other.

45. An apparatus for finishing a semiconductor wafer having a subsystem controller, the subsystem controller having access to a manufactured article having a computer readable medium with computer readable instructions for performing the method of claim 39.

46. At least three apparatus according to claim 45 wherein the at least three apparatus are in operative communication with each other.

47. A method for finishing a semiconductor wafer having tracked information, the method comprising:

a step (A) providing a semiconductor wafer and wherein the semiconductor wafer surface has a first uniform region and a second uniform region;

a step (B) providing a finishing surface;

a step (C) providing an organic lubricant proximate the semiconductor wafer;

a step (D) providing at least one control subsystem having at least three operative process sensors, at least one processor, and a controller and wherein the at least one processor for processing:

(i) the tracked information,

(ii) historical performance including a quantity of historical tracked information of the semiconductor wafer and a quantity of historical tracked information of prior semiconductor wafers, and

(iii) a cost of manufacture information;

a step (E) applying an operative finishing motion to an interface between the semiconductor wafer and the finishing surface and wherein the interface includes the organic lubricant in the first uniform region;

a step (F) sensing an in situ finishing information during finishing with the at least three operative process sensors during a finishing cycle time;

a step (G) evaluating a multiplicity finishing information and wherein at least a plurality of the multiplicity of the finishing information has an effect on a cost of manufacture of the semiconductor wafer;

a step (H) determining a change for at least one process control parameter using:

(i) the tracked information,

(ii) the historical performance including the quantity of historical tracked information of the semiconductor wafer and the quantity of historical tracked information of the prior semiconductor wafers,

(iii) the cost of manufacture information,

(iv) the in situ finishing information, and

(v) the step (G) of evaluating the multiplicity of finishing information; and

a step (I) changing the at least one control parameter to change the finishing in at least the first uniform region of semiconductor wafer surface during the finishing cycle time;

a step (J) storing at a least a portion of the information in the step (H) forming a family of stored information;

a step (K) using the family of stored information to determine a change for at least one particular member of the family of stored information;

a step (L) changing the at least one particular member in the family of stored information forming a changed family of stored information; and

a step (M) using the changed family of stored information.

48. A method of finishing according to claim 34 wherein the step (L) of changing at least one particular member comprises changing at least one particular member selected from the group consisting of (ii) the historical performance including the quantity of historical tracked information of the semiconductor wafer and the quantity of historical tracked information of the prior semiconductor wafers and (iii) the cost of manufacture information,

49. A processor-readable, program storage device encoded with instructions that, when executed by a processor, performs the method of claim 47.

50. A control subsystem having access to a manufactured article having a processor readable medium with processor readable instructions for performing the methods of claim 47.

51. At least three control subsystems according to claim 50 wherein the at least three control subsystems are in operative communication with each other.

52. An apparatus for finishing a semiconductor wafer having a subsystem controller, the subsystem controller having access to a manufactured article having a computer readable medium with computer readable instructions for performing the method of claim 39.

53. At least three apparatus according to claim 52 wherein the at least three apparatus are in operative communication with each other.

54. A method for finishing a semiconductor wafer having tracked information, the method comprising:

a step (A) providing a semiconductor wafer and wherein the semiconductor wafer surface has a first uniform region and a second uniform region;

a step (B) providing a finishing surface;

a step (C) providing an organic lubricant proximate the semiconductor wafer;

a step (D) providing at least one control subsystem having at least three operative process sensors, at least one processor, and a controller and wherein the at least one processor for processing:

(i) the tracked information,

(ii) historical performance including a quantity of historical tracked information of the semiconductor wafer and a quantity of historical tracked information of the prior semiconductor wafers, and

(iii) a cost of manufacture information;

a step (E) applying an operative finishing motion to an interface between the semiconductor wafer and the finishing surface and wherein the interface includes the organic lubricant in the first uniform region;

a step (F) sensing an in situ finishing information during finishing with the at least three operative process sensors during a finishing cycle time;

a step (G) evaluating a multiplicity finishing information and wherein at least a plurality of the multiplicity of the finishing information has an effect on a cost of manufacture of the semiconductor wafer;

a step (H) determining a change for at least two process control parameter using:

(i) the tracked information,

(ii) the historical performance including the quantity of historical tracked information of the semiconductor wafer and the quantity of historical tracked information of the prior semiconductor wafers,

(iii) the cost of manufacture information,

(iv) the in situ finishing information, and

(v) the step (G) of evaluating the multiplicity of finishing information; and

a step (I) changing the at least one control parameter to change the finishing in at least the first uniform region of semiconductor wafer surface during the finishing cycle time;

a step (J) storing at a least a portion of the information in the step (H) forming a family of stored information;

a step (K) using the family of stored information to determine a change for at least one particular member of the family of stored information;

a step (L) changing the at least one particular member in the family of stored information forming a changed family of stored information; and

a step (M) using the changed family of stored information.

55. A method of finishing according to claim 54 wherein the step (L) of changing at least one particular member comprises changing at least one particular member selected from the group consisting of (ii) historical performance including the quantity of historical tracked information of the semiconductor wafer and the quantity of historical tracked information of the prior semiconductor wafers and (iii) the cost of manufacture information.

56. A processor-readable, program storage device encoded with instructions that, when executed by a processor, performs the method of claim 54.

57. A control subsystem having access to a manufactured article having a processor readable medium with processor readable instructions for performing the methods of claim 54.

58. At least three control subsystems according to claim 57 wherein the at least three control subsystems are in operative communication with each other.

59. An apparatus for finishing a semiconductor wafer having a subsystem controller, the subsystem controller having access to a manufactured article having a computer readable medium with computer readable instructions for performing the method of claim 54.

60. At least three apparatus according to claim 59 wherein the at least three apparatus are in operative communication with each other.

61. A method for finishing a semiconductor wafer having tracked information, the method comprising:

a step (A) providing a semiconductor wafer;

a step (B) providing a finishing surface;

a step (C) providing at least one control subsystem having at least three operative process sensors, at least one processor, and a controller and wherein the at least one processor for processing:

(i) the tracked information,

(ii) historical performance including a quantity of historical performance of prior semiconductor wafers, and

(iii) a cost of manufacture information;

a step (D) applying an operative finishing motion to an interface between the semiconductor wafer and the finishing surface;

a step (E) sensing an in situ finishing information during finishing with the at least three operative process sensors during a finishing cycle time;

a step (F) evaluating a multiplicity finishing information and wherein at least a plurality of the multiplicity of the finishing information has an effect on a cost of manufacture of the semiconductor wafer;

a step (G) determining a change for at least one process control parameter using:

(i) the tracked information,

(ii) the historical performance including the quantity of historical performance of prior semiconductor wafers,

(iii) the cost of manufacture information,

(iv) the in situ finishing information, and

(v) the step (F) of evaluating the multiplicity of finishing information; and

a step (H) changing the at least two of control parameters to change the finishing on at least one region of semiconductor wafer surface during the finishing cycle time.

62. A method according to claim 61 wherein the step (F) and (G) are performed at least in part during the same time.

63. A method according to claim 61 wherein the step (F) and (G) are performed at least in part at different times.

64. A processor-readable, program storage device encoded with instructions that, when executed by a processor, performs the method of claim 61.

65. A control subsystem having access to a manufactured article having a processor readable medium with processor readable instructions for performing the methods of claim 61.

66. At least three control subsystems according to claim 65 wherein the at least three control subsystems are in operative communication with each other.

67. An apparatus for finishing a semiconductor wafer having a subsystem controller, the subsystem controller having access to a manufactured article having a computer readable medium with computer readable instructions for performing the method of claim 61.

68. At least three apparatus according to claim 67 wherein the at least three apparatus are in operative communication with each other.

69. A method for finishing a semiconductor wafer having tracked information, the method comprising:

a step (A) providing a semiconductor wafer and wherein the semiconductor wafer surface has a first uniform region and a second uniform region;

a step (B) providing a finishing surface;

a step (C) providing at least one control subsystem having at least three operative process sensors, at least one processor, and a controller and wherein the at least one processor for processing:

(i) the tracked information,

(ii) historical performance including a quantity of historical tracked information of the semiconductor wafer and a quantity of historical tracked information of prior semiconductor wafers, and

(iii) a cost of manufacture information;

a step (D) applying an operative finishing motion to an interface between the semiconductor wafer and the finishing surface and wherein the interface includes the first uniform region;

a step (E) sensing an in situ finishing information during finishing with the at least three operative process sensors during a finishing cycle time;

a step (F) evaluating a multiplicity finishing information, and at least a plurality of the multiplicity of the finishing information have an effect on a cost of manufacture of the semiconductor wafer;

a step (G) determining a change for at least one process control parameter using:

(i) the tracked information,

(ii) the historical performance including the quantity of historical tracked information of the semiconductor wafer and the quantity of historical tracked information of the prior semiconductor wafers,

(iii) the cost of manufacture information,

(iv) the in situ finishing information, and

(v) the step (F) of evaluating the multiplicity of finishing information; and

a step (H) changing the at least one control parameter to change the finishing in at least the first uniform region of semiconductor wafer surface during the finishing cycle time;

a step (I) storing at a least a portion of the information in the step (G) forming a family of stored information;

a step (J) using the family of stored information to determine a change for at least one particular member of the family of stored information;

a step (K) changing the at least one particular member in the family of stored information forming a changed family of stored information; and

a step (L) using the changed family of stored information.

70. A method of finishing according to claim 34 wherein the step (K) of changing at least one particular member comprises changing at least one particular member selected from the group consisting of (ii) the historical performance including the quantity of historical tracked information of the semiconductor wafer and the quantity of historical tracked information of the prior semiconductor wafers and (iii) the cost of manufacture information,

71. A processor-readable, program storage device encoded with instructions that, when executed by a processor, performs the method of claim 70.

72. A control subsystem having access to a manufactured article having a processor readable medium with processor readable instructions for performing the methods of claim 70.

73. At least three control subsystems according to claim 72 wherein the at least three control subsystems are in operative communication with each other.

74. An apparatus for finishing a semiconductor wafer having a subsystem controller, the subsystem controller having access to a manufactured article having a computer readable medium with computer readable instructions for performing the method of claim 70.

75. At least three apparatus according to claim 74 wherein the at least three apparatus are in operative communication with each other.

76. A method for finishing a semiconductor wafer having tracked information, the method comprising:

a step (A) providing a semiconductor wafer and wherein the semiconductor wafer surface has a first uniform region and a second uniform region;

a step (B) providing a finishing surface;

a step (C) providing at least one control subsystem having at least three operative process sensors, at least one processor, and a controller and wherein the at least one processor for processing:

(i) the tracked information,

(ii) historical performance including a quantity of historical tracked information of the semiconductor wafer and a quantity of historical tracked information of the prior semiconductor wafers, and

(iii) a cost of manufacture information;

a step (D) applying an operative finishing motion to an interface between the semiconductor wafer and the finishing surface and wherein the interface includes in the first uniform region;

a step (E) sensing an in situ finishing information during finishing with the at least three operative process sensors during a finishing cycle time;

a step (F) evaluating a multiplicity finishing information, and where at least a multiplicity of the multiplicity of finishing information have an effect on a cost of manufacture of the semiconductor wafer;

a step (G) determining a change for at least two process control parameter using:

(i) the tracked information,

(ii) the historical performance including the quantity of historical tracked information of the semiconductor wafer and the quantity of historical tracked information of the prior semiconductor wafers,

(iii) the cost of manufacture information,

(iv) the in situ finishing information, and

(v) the step (F) of evaluating the multiplicity of finishing information; and

a step (H) changing the at least one control parameter to change the finishing in at least the first uniform region of semiconductor wafer surface during the finishing cycle time;

a step (I) storing at a least a portion of the information in the step (G) forming a family of stored information;

a step (J) using the family of stored information to determine a change for at least one particular member of the family of stored information;

a step (K) changing the at least one particular member in the family of stored information forming a changed family of stored information; and

a step (L) using the changed family of stored information.

78. A method of finishing according to claim 77 wherein the step (K) of changing at least one particular member comprises changing at least one particular member selected from the group consisting of (ii) historical performance including the quantity of historical tracked information of the semiconductor wafer and the quantity of historical tracked information of the prior semiconductor wafers and (iii) the cost of manufacture information.

79. A method of finishing according to claim 77 wherein the step (L) of using the changed family of stored information comprises using the changed family of stored information for at least in part determining a change for a particular process control parameter during finishing of a future semiconductor wafer.

80. A method of finishing according to claim 77 wherein the step (L) of using the changed family of stored information comprises using the changed family of stored information for at least in part determining a change for a particular process control parameter during finishing of a future semiconductor wafer layer.

81. A processor-readable, program storage device encoded with instructions that, when executed by a processor, performs the method of claim 77.

82. A control subsystem having access to a manufactured article having a processor readable medium with processor readable instructions for performing the methods of claim 77.

83. At least three control subsystems according to claim 82 wherein the at least three control subsystems are in operative communication with each other.

84. An apparatus for finishing a semiconductor wafer having a subsystem controller, the subsystem controller having access to a manufactured article having a computer readable medium with computer readable instructions for performing the method of claim 77.

85. At least three apparatus according to claim 84 wherein the at least three apparatus are in operative communication with each other.

86. A method of finishing according to claim 77 wherein the step (L) of using the changed family of stored information comprises using the changed family of stored information for at least in part determining an appreciable finishing change for a future finishing of semiconductor wafer.

87. A method of finishing according to claim 77 wherein the step (L) of using the changed family of stored information comprises using the changed family of stored information for at least in part determining an appreciable finishing change for a future finishing of a future semiconductor wafer layer.

88. A method of finishing according to claim 77 wherein the step (L) of using the changed family of stored information comprises using the changed family of stored information for at least in part determining an appreciable change for a process model.

89. A method of finishing according to claim 77 wherein the step (L) of using the changed family of stored information comprises using the changed family of stored information for at least in part determining an appreciable change for a forecast of the cost of manufacture.

90. A method of finishing according to claim 77 wherein the step (L) of using the changed family of stored information comprises using the changed family of stored information for at least in part determining an appreciable change for a forecast of the variable cost of manufacture.